ECE336 – MICROPROCESSORS I

WEEK 11

PIC16F84 TIMERS & COUNTERS

PIC16F84 TIMER PROGRAMMING

The PIC16F84 has two timers depending on the family member. They are referred to as Timer 0 and Watchdog timer (WDT). they can be used either as timers to generate a time delay or as counters to count events happening outside the microcontroller.

Every timer needs a clock pulse to tick. The clock source can be internal or external. If we use the internal clock source, then 1/4th of the frequency of the crystal oscillator on the OSC1 (Fosc/4) pin is fed into the timer. Therefore it is used for time delay generation and for that reason is called a timer.

By choosing the external clock option, we feed pulses through one of the PIC16's pins: this is called a counter.

TIMER 0 (TMR0) register

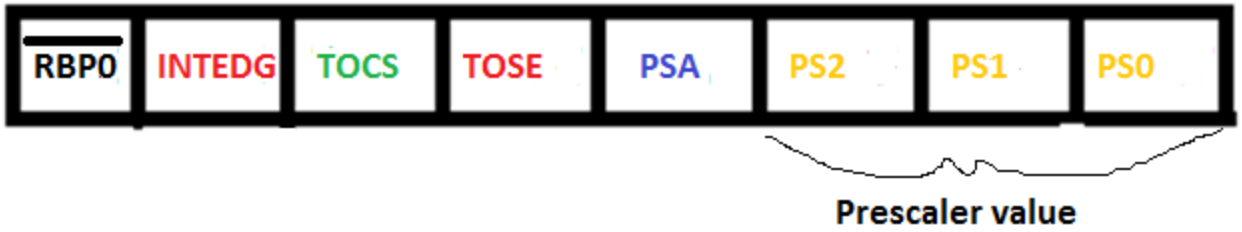
TMR0 is an 8-bit special function register in the RAM. It has the following features;

- 8-bit timer/counter
- Readable and writable
- It has prescaler value
- Internal or external clock can be selected
- Edge can be selected for external clock (rising or falling edge)
- Interrupt occurs when TMR0 counts from h'FF' to h'00' (Timer overflow interrupt)

OPTION REGISTER

- It is an 8-bit special function register in the RAM. It controls the prescaler value of TMR0 and WDT. Also it controls the edge of the external interrupt signal and clock signal. The following figure shows the OPTION register with all control bits.

OPTION REGISTER



TOCS: TMR0 clock source select bit

1=External clock from RA4/TOCK1

0=Internal clock (Fosc/4 from OSC1)

TOSE: TMR0 source edge select bit

1= Increment on H-to-L transition on RA4/TOCK1

0= Increment on L-to-H transition on RA4/TOCK1

PSA: Prescaler assignment bit,

1=Prescaler is assigned to the WDT

0=Prescaler is assigned to the TMR0

Prescaler value for TMR0 and WDT

Prescaler value	TMR0_rate	WDT_rate
000	1/2	1/1
001	1/4	1/2
010	1/8	1/4
011	1/16	1/8
100	1/32	1/16
101	1/64	1/32
110	1/128	1/64
111	1/256	1/128

- TMR0 or WDT rate determines the increment period. If TMR0=1/2, TMR0 increases every 2 instruction cycle. If TMR0=1/128, TMR0 increases every 128 instruction cycle.

Exp:If presclalar value is b’000’, what is the increment period of TMR0 and maximum interrupt delay. (Oscillator frequency 4 MHz)

Sol: internal frequency=4MHz/4=1MHz

ICT (Instruction cycle time)=1/1MHz=1us

Prescaler value=000, TMR0_rate=1/2

IP(Increment period)=2x1us=2us

Timer overflow Interrupt occurs when TMR0 counts from h’FF’ to h’00’. There are 256 numbers between h’00’ to h’FF’ for maximum interrupt delay.

ID(Interrupt delay)=IPx256=2usx256=512us

Exp: To generate 1.28ms interrupt delay, what will be the first number of the TMR0.(Fosc=4MHz, Prescaler=110)

Sol:

Internal frequency=4MHz/4=1MHz

ICT (Instruction cycle time)=1/1MHz=1us

For 1.28ms ID, 1.28ms/1us=1280 instruction.

Prescaler=110; TMR0 increases every 128 instruction cycle. 1280 /128=10 ,

To create 1.28ms interrupt delay, TMR0 should count 10 number.

Timer overflow Interrupt occurs when TMR0 count from h'FF' to h'00'. 256-10=246;First number of the TMR0**=246.**

Exp: Write a program to make the flash the bit_0 of PORTB. Use TMR0 for delay between each flash. Signal source is the internal clock and TMR0_rate=1/256.

TMR0_INTERRUPT

- **Exp:** Write a program to increment the value of PORTB at each timer overflow. (Use TMR0 interrupt)